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## On the habits of a TIPULIDEOUS LARVA.

BY EDW. D. COPE.

There has been known in Europe for many years a small white larva, which is called the army worm, which gathers itself into large bodies forming streams of several feet in length. These bodies move forward at a slow rate, and appear to be a form of migration which the species adopts for some purpose unknown. Their superficial resemblance to a sluggish serpent usually excites repugnance in the minds of many observers. It has been found that these larvæ are those of different species of the flies of the genus *Sciara*, which belongs to the *Mycetophilidæ*, which was formerly regarded as a group of the great family *Tipulidæ*, or the crane flies.

Of this genus Osten Sacken\* says: "All the larvæ of the *Mycetophilidæ* are gregarious, and live among decaying vegetable matters. \* \* *Sciara* is found among decaying leaves in vegetable mould, in cow-dung, under the bark of dead trees, etc. \* \* They may be distinguished from the larvæ of *Mycetophila* by their greater delicacy, and by the structure of the trophi; most of them seem to have no bristles or spines on the locomotive processes on the under side of the body, whereas the majority of the *Mycetophilæ* have them. They are even more gregarious than the other larvæ of this family, and have the singular propensity of sticking together in dense patches, in which situation they are frequently found, for instance, under the bark of trees. It is probably to the same propensity that the phenomenon, known in Germany under the name of army worm (*Heerwurm*), is due. This is a procession of larvæ, sometimes from twelve to fourteen feet long, and two or three inches broad, consisting of numberless specimens, sticking closely together, and forming a layer of about half an inch thickness. Such processions have been often observed in woods in Germany, Sweden and Russia, but never sufficiently investigated to explain their object. That the larvæ do not migrate in search of food, we can infer from the fact that they appear to be full-grown when they form these processions."

Prof. Berthold, of the University of Göttingen, gives a more detailed account of this larva,† as follows:

"Mr. Berthold imparted, on the 17th of December, 1853, to the Royal Society of Sciences, a zoological examination of the *Heerwurm* (army worm), which in certain years in the forests of Thuringia, Hanover, Sweden and Norway moves like a snake several feet long, four to six inches broad, and thumb thick, which consists of myriads of small dipterous larvæ, four to five lines long. Eight years ago (Reports from the G. A. University and the Royal Society of Sciences at Goettingen, 1845, No. 5), he stated that the *Tipula* which was observed by the forest keeper, Mr. Raude, at Birkenmoor, was the *Thomastrauer gnat* (*Sciara thomæ*), and was the means of solving a problem, which has been for hundreds of years a returning stimulus of bigotry and fear for the peasants, and for zoologists a point of earnest consideration. But when he obtained last summer from the Eilenriede, near Hanover, more new *Heerwurm* larvæ, and Mr. L. Bechstein bred some flies out of the larvæ of a *Heerwurm*, it gave him occasion to institute further examinations.

"The desire for association and migration cannot be compared with the migrations of all other insects and animals; for this is not done to procure nourishment, because the maggots are in such great quantity above each other, that but few would have a chance to reach the food. Also, the maggots do not show the desire for travelling immediately after leaving the egg, like many other insects, but the movement commences when the worm

\* Who has described the larvæ, and given the bibliography of the European species, *Proc. Entom. Soc. Phila* 1854 163—170 I am indebted to this excellent entomologist for the identification of larvæ from Westtown, sent him, and for reference to the above essay.  
† *Nachrichten Univ. Göttingen*, 1854, p. 1.

is grown, and not less than three lines long. From this it would appear to have some connection with the entrance into the pupa state.

"Their metamorphosis is known; it takes place in earth, in roots of plants, under rotten logs, or in swamps. Such moist localities are selected by the Heerwurm larvæ after they have come to a certain age, and the time of pupa change has arrived, which is known by the desire for association.

"The mucus which keeps the maggots together is a product of the salivary gland in *Sciara ingenua*, and almost all other Dipterous larvæ which have a head, and which make a fine cocoon. The formation of pupæ of the Heerwurm takes place surrounded by this mucous saliva. The Heerwurm can be regarded as a collection of larvæ, for the purpose of mutual transformation; that is, it is accomplished through mutual protection at a period favorable to development. This connection is given up before the formation of nymphs really arrives, the individuals separating, from time to time, in search of food. When now the larvæ of large divisions of Diptera, as the Pupipares, Notacanthes, etc., have the peculiarity of changing their own skin into a cover, which is the grave of the larva and the cradle for the pupa; and the larvæ of another division of the Diptera, as the Tanystomes and the Nemoceres, before changing, strip off their cover, and are transformed free or in a cocoon, so the *Sciara thomæ* presents a process intermediate between these, as the construction of the cocoon is not performed within the skin of the larva itself, but in a cavity which is made of the skins of numbers of other larvæ."

There appears, however, to have been no record of the observation of this peculiar habit of larvæ in North America, up to within a short time. The genus is known to exist here, and Osten Sacken (l. c.) describes a species which he calls *Sciara toxoneura*. Hence the following account, which I have received from my friend William Kite, teacher at Westtown School, in Chester county, Pa., is of considerable interest. The statements are those of a careful naturalist, well acquainted with the field and field study. Before quoting it, it must be noted that another account of the same phenomenon was published in *The Friend* journal (Philada., 1864), by Charles Potts, another teacher in the same excellent institution. Some statements of this writer need correction, as further observation convinced him: *e. g.*, that they could climb.

The following are observations of Wm. Kite:—

"On the morning of Ninth month 11th, 1866, a company of worms was observed crossing the brick walk, or passage, east of Westtown School; the mass presented much the appearance of a thin grey snake. This is the third year that these worms have been seen about our grounds.

"This company extended over a length of about twenty-two inches, with a breadth of from three-quarters of an inch in the thickest part, to about one-eighth of an inch at the head, and one-tenth at the tail; five or six worms deep in thicker parts. The mode of progression of these singular creatures was by the contraction of an annulus at a time. They had distinct heads, and the motion of each was like that observed in caterpillars rather than that seen in earth-worms. The contraction commenced posteriorly, and was passed forward to the head in the successive rings.

"They advanced at the rate of four inches in five minutes, the hinder ones working their way over the top of the rest. Those who reached the ground or bricks by thus traversing their comrades' backs seemed unable to proceed, so that their progression naturally assumed the singular shape that drew our attention to them. Occasionally a few would diverge from the mass, near the front, forming another head, as it were; but they would soon return to the general company by crawling back over each other."

[This observation was also made on the procession which appeared in 1864; *i. e.*, that the hinder ones progressed over the bodies of those that preceded, the whole mass thus taking up in the rear and laying down in front. This is a much more rational explanation of their progress than has been offered; we 1867.]

having been left to suppose that the lower stratum of larvæ carry the general mass.—E. D. C.]

"To arrive at an idea of their numbers, about half an inch of them were lifted out of their ranks on the point of a knife; of these 95 adhered to it, giving say 200 to the inch, or, by rough estimation, 2400 in the party.

"They were about half an inch long, semi-transparent, with black heads; their alimentary canals were clearly distinguishable by the unaided eye; the color of their contents would lead to the supposition that their food resembled that of the earth-worm. They crossed the brick path, conforming to one general direction, but varying to suit the inequalities of the walk. On reaching the grass they immediately buried themselves in the ground. This was observed to happen with a company which was seen here a year or two ago."

"*Seventh mo.* 1. 1867.

"A large company of the 'snake worms' attempted to cross a gravel walk in the yard this morning, but became entangled in the sand, which adhered to their bodies and seemed to bewilder them. School duties interfered with watching them, but I anticipated their perishing in the sand. They had managed to keep together when I saw them, after having crawled through three or four feet of sandy gravel, and may have eventually escaped.

"The most noticable fact in regard to them was the presence among them, travelling with and over them, of a full-grown maggot of a fly! It was very lively, diving into the mass and emerging again, as though quite at home. How did it get there? and why did it associate with them? Was it hatched among them?

"Their course was about N. W."

"*Seventh mo.* 5. 1867.

"A small company of *those worms* again on the gravel walk, within a few feet of the same place as on the 1st inst. As they were going in an opposite direction from those on the 1st, they may be the same company. There were several many-footed worms, about an inch long, accompanying them; these were engaged in pulling worms out of the procession and devouring them. On both occasions the companies were noticed early in the morning, as though they commenced moving in the night.

"Their course was about S."

"*Seventh mo.* 8. 1867.

"A much larger company of these worms were on the brick walk. They had nearly crossed the walk before 7 A. M., showing they commenced moving early in the morning. They appeared unusually lively. Upon careful examination, we found the train extending back into the grass eighteen inches to a cluster of them which appeared to be issuing out of the ground. They moved on the surface of the ground, winding among the grass to avoid the stems. This disproves our former supposition that they emerged to avoid some obstruction. We were necessarily called off, and on our return the traces of them were lost. Some ants and one small worm seemed engaged in eating them; the worms apparently appreciated their danger, shrinking from the touch of these animals. This procession measured six feet six inches. Occasionally one would be left on the ground after the train had passed, but most of them kept with the general mass.

"Their course was about N. W."

"*Seventh mo.* 9. 1867.

"Two more small companies of these worms appeared, apparently the remains of the large party of yesterday. Each company was short of a foot in length, and were accompanied by quite a number of the worms noticed before with them. I caught and preserved a number of these; they resemble the worms found in cured meat, or similar ones found in many garden vegetables. Their connection with the emigrant parties seems to be that of enemies, preying on them.

"Course N. W."

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"*Seventh mo.* 15, 1867.

"7 o'clock.—A cool morning. Found a small company of these worms on the brick walk near the office. Some passer had trod on them, and they were thrown into confusion; added to this, a colony of ants had intercepted their course, and carried them off in numbers. They were massed in a crowd, and their efforts to move on were defeated by the ants seizing their leaders at each attempt to move.

"8.30.—The perseverance of the ants in carrying away the worms seems to demoralize them entirely, and finally two bricks being placed to protect them from passers' feet, the greater portion of them crept under one of them and huddled together in a confused mass, where they became an easy prey to their indefatigable little enemies, who were to be seen through the morning marching off with their captives, though much larger than themselves.

"10 o'clock.—All gone.

"Course, so far as they were permitted to go, N. W."

The "many-footed worms" which devoured the *Sciara* larvæ were larvæ of some species of the Coleopterous family Staphylinidæ. Several specimens were sent with the *Sciara*.

I am also informed that a procession of this species has been seen on Quaker Hill, in the borough of West Chester. Dr. Benj. H. Coates informs me that he has seen their trains in Hunterdon county, N. J., and T. A. Conrad saw them some years ago in his garden in Burlington, in the same State.

On inquiry of my friend Jacob Stauffer, of Lancaster, whose MS. notes on the species of insects of his region, and their habits, are numerous, I received the following additions to our stock of knowledge of the habits of the larva of the *Sciara*:

"On the 10th of August, 1865, Mr. Rathvon and myself were informed by Dr. Geo. McCalla that we would be interested by examining an army of small shining worms on the march in the yard of Col. D. Patterson, in W. King street, Lancaster.

"On our arrival we found the order of march thrown into great confusion by boiling water, which the women had poured along the line. I collected quite a number of stragglers from the main army thus routed, as did also friend Rathvon. These I subjected to a close examination under a strong magnifying power. My notes read thus: 'A portion, about two feet in length, looked like a shining cord, not uniform in outline, yet compact. These larvæ were about half an inch long mostly, perhaps three-eighths of an inch, and seven-sixteenths and one-thirty-second parts of an inch in diameter. Their heads of a glossy jet-black color, as also the anterior edge of the first joint of segment; rest of the first, and the second and third joints of a translucent milky-white, dorsally watery, with an interior wavy, brownish, intestinal canal, visible through the transparent skin; there is also a lateral tinge or bronze-yellow; otherwise of a shining, water-and-milk-like color. I could observe no pectoral or anal legs; they moved by contracting and extending the segments of their body (twelve in number) alternately, like that of a dipterous larva of Tipulidæ. In motion the convolutions of the intestinal canal were very apparent. They seemed to interlace with each other, but, having been disturbed, I cannot venture to say whether after any precise order, or by simple conglomeration as chance may demand. When first seen they were moving in a broad columnar mass, rope-like, seeming like a shining guard-chain cord, of considerable thickness and quite ornamental, like jet beads mixed in with pearly-white beads in motion.'

"The following is a copy from a letter by Prof. W. S. Roedel, Wytheville, Virginia, Aug. 4. 1865, in his own words:

"On Saturday, July 15, 1865, at North Lebanon, Pa., I observed in a path at the foot of a hill, what I at first glance supposed to be the cast-off skin of a serpent, which the object resembled in color and general appearance, but what, 1867.]

upon close inspection, I found to be a multitude of caterpillars, a half-inch in length and one-thirty-second part of an inch in diameter; head of a dull red or brownish color, bodies smooth and somewhat glistening.

"These worms moved upon one another, piled upon and irregularly interwoven among each other like a flattened rope. The head of the column was much broader than the rest, being two inches wide, from which dimension the column gradually tapered (to a point, I suppose, for I did not see the end of it). The length of the column was four feet to a fence, beyond which I did not examine it.

"A portion of the column lay in the grass, through which it moved without interruption, as if it had been a solid mass. The rate of motion was extremely slow, not exceeding one-eighth of an inch in a minute. The color of the mass was as much like a rope of tow which has been exposed to the weather as anything I can think of; it might be called a rusty gray. The column was not cylindrical,—that is, a cross section would be elliptical."

"The Springfield (Mass.) Republican of August, 1865, gives an account of a 'reptile' found at Lee. It was nearly four feet in length, about the size of a man's finger, and shaped like a whip-lash; and on close examination the whole body was found to be composed of small worms about half an inch in length, with large black heads, and semi-transparent body. On separating them into fragments, they would immediately re-form into a snake-shape, and crawl slowly off. One or two similar snakes have recently been seen in that vicinity.' This was copied into the Lancaster Evening Express of Saturday, Aug. 12, 1865."

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#### The Mechanical Theory of SOLAR HEAT.

BY JACOB ENNIS.

During the last quarter of a century scientific men have endeavored by new methods to account for the heat of the sun, and they now generally believe, or incline to believe, in its mechanical origin. Some adopt the meteoric theory. They suppose that meteorites are falling with great velocity in the sun, and that these stones strike the enormous solar fire by their fall. Others adopt the nebular theory. They suppose that the sun and all his attending planets and satellites have condensed from a very rare nebulous condition, and that the mere condensation, or falling together of their materials by the force of gravity, has produced all the solar heat. Others again combine both these theories. They believe that originally the sun and the earth were heated to a fused condition by mere condensation, and that since then the meteorites have continued the heat of the sun. The only source of heat by all these theories is gravity, because gravity causes the fall of matter, whether in a nebulous or a meteoric condition, and this falling, this mechanical force, is converted into heat. My object in this paper is to show that none of these views can stand the test of numbers and of well established facts. The high place which the mechanical theory of solar heat now holds in the scientific world, is my apology for this appearance.

Some of the important statements of the highly distinguished gentlemen who have formed the mechanical theory are these:

I. Dr. Julius Robert Mayer, of Heilbronn, says that a mass of burning coal equal to that of the sun would supply his present emission of heat only 4600 years; and that a meteorite falling into the sun would supply at least 4600 times more heat than the same weight of burning coal. Hence a mass of meteorites equal to the sun would supply his heat  $4600 \times 4600 = 21,160,000$  years. This would be the least amount of heat when, as is most natural, that mass of meteorites should approach the sun spirally. If they should fall in a direct line, as would be most unlikely, the heat would be double this amount. This greatest possible amount of heat, being out of probability, is

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